



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
-----------------	-------------	----------------------	---------------------	------------------

10/711,764

10/04/2004

Toshiharu Furukawa

BUR920040152US1

5763

37692

7590

12/13/2005

WOOD, HERRON & EVANS, LLP (IBM-BUR)

2700 CAREW TOWER

441 VINE STREET

CINCINNATI, OH 45202

EXAMINER

STARK, JARRETT J

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 12/13/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

10/711,764

Applicant(s)

FURUKAWA ET AL.

Examiner

Jarrett J. Stark

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☐ Responsive to communication(s) filed on 04 October 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-23 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-23 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 04 October 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

Art Unit: 2823

## DETAILED ACTION

### *Election/Restrictions*

Claims 24-45 withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected method of manufacturing a semiconductor device, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 12/01/2005.

### *Claim Rejections - 35 USC § 102*

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

**Claims 1, 2, 4, 5, 9, & 10** are rejected under 35 U.S.C. 102(e) as being anticipated by Lyons et al. (US 6,790,790).

Art Unit: 2823

**Regarding claim 1, Lyons** discloses a dielectric material for forming a structure of an integrated circuit, said dielectric material comprising a plurality of carbon nanostructures. (Lyons, col. 2 lines 61-67 & Lyons, col. 3, lines 30-35)

**Regarding claim 2, Lyons** discloses the dielectric material of claim 1 wherein said carbon nanostructures comprise a plurality of carbon nanotubes. (Lyons, col. 3, lines 30-35)

**Regarding claim 4, Lyons** discloses the dielectric material of claim 1 wherein said dielectric material has a dielectric constant of less than about 3. (Lyons, col. 2 lines 61-67)

**Regarding claim 5, Lyons** discloses the dielectric material of claim 1 wherein said structure further comprises at least one conductive feature disposed in said dielectric material. (Lyons, col. 4, lines 41-54)

**Regarding claim 9, Lyons** discloses the dielectric material of claim 1 further comprising:

a copolymer layer binding said carbon nanostructures to define the dielectric material. (Lyons, col. 3, lines 4-28)

**Regarding claim 10, Lyons** discloses the dielectric material of claim 7 wherein said carbon nanostructures and said copolymer layer have an effective dielectric constant of less than about 3. (Lyons, col. 2 lines 61-67)

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

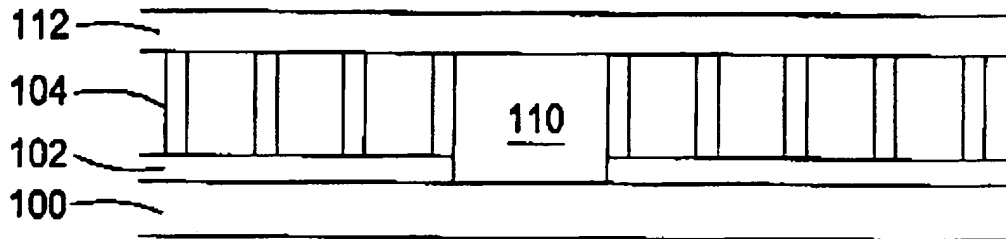
1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

**Claims 7, 8, 11-13, 15,16, & 18-23** are rejected under 35 U.S.C. 103(a) as being unpatentable over Lyons et al. (US 6,790,790) in view of Nguyen et al. (US 2004/0169281).

**Regarding claim 7**, Lyons discloses the dielectric material of claim 1.

Lyons does not disclose the device further comprising a cap layer on said dielectric material.

Nguyen discloses a device made up of a low-k carbon nanotube material further comprising a cap layer on said dielectric material. (Nguyen, [0020] & Fig. 1C)



Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to add a cap layer. The cap layer may be a silicon oxide layer or another dielectric layer. (Nguyen, [0035])

**Regarding claim 8,** Lyons in view of Nguyen disclose the dielectric material of claim 7 wherein said carbon nanostructures and said cap layer have an effective dielectric constant of less than about 3. (Lyons, col. 2 lines 61-67)

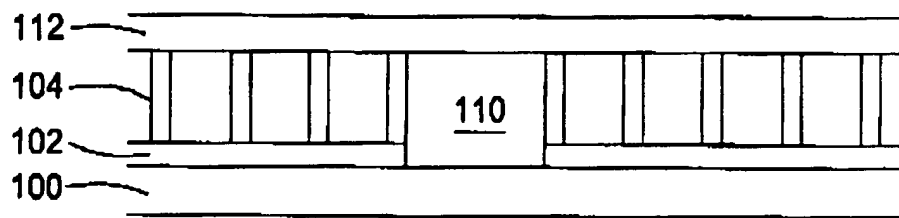
**Regarding claim 11,** Lyons in view of Nguyen disclose the semiconductor structure formed on a substrate, comprising:

a dielectric layer comprising a plurality of carbon nanostructures; and (Lyons, col. 3, lines 30-35)

at least one conductive feature in said dielectric layer, said conductive feature electrically isolated from nearby conductive features by portions of said dielectric layer. (Lyons, col. 4, lines 41-54)

Art Unit: 2823

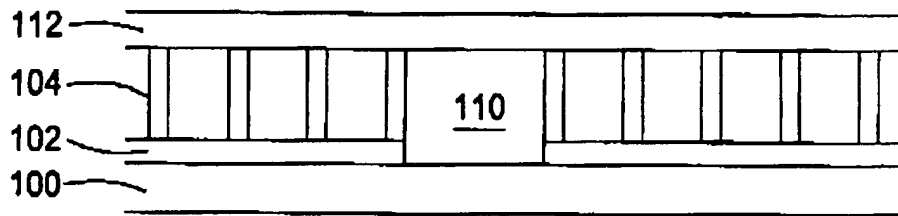
**Regarding claim 12, Lyons** in view of **Nguyen** disclose the semiconductor structure of claim 11 wherein said dielectric layer has an exposed surface, and further comprising: a cap layer of an insulating material at least partially covering said exposed surface, said cap layer having (**Nguyen** Fig. 1C, 112) a top surface, and said conductive feature (**Nguyen** Fig. 1C, 110) having a top surface substantially coplanar with said top surface of said cap layer (**Nguyen** Fig. 1C, 112).



**Regarding claim 13, Lyons** in view of **Nguyen** disclose the semiconductor structure of claim 11 wherein said carbon nanostructures comprise a plurality of carbon nanotubes. (**Lyons**, col. 3, lines 30-35)

**Regarding claim 15 Lyons** in view of **Nguyen** disclose the semiconductor structure of claim 11 wherein said dielectric layer has a dielectric constant of less than about 3. (**Lyons**, col. 2 lines 61-67)

**Regarding claim 16** Lyons in view of Nguyen disclose the semiconductor structure of claim 11 wherein said structure comprises a plurality of conductors (Nguyen Fig. 1C, 110) electrically isolated by said layer of said dielectric material (Nguyen Fig. 1C, 104).



**Regarding claim 18** Lyons in view of Nguyen disclose the semiconductor structure of claim 11 further comprising:  
a cap layer (Nguyen Fig. 1C, 112). disposed on said carbon nanostructures.

**Regarding claim 19** Lyons in view of Nguyen disclose the semiconductor structure of claim 18 wherein said carbon nanostructures and said cap layer collectively have a dielectric constant of less than about 3. (Lyons, col. 2 lines 61-67)

**Regarding claim 20** Lyons in view of Nguyen disclose the semiconductor structure of claim 11 further comprising:



a substrate selected from the group consisting of an interconnect level, a dielectric material, a buried barrier layer, a metallization line, and a semiconductor wafer. (Lyons, col. 4, lines 41-54) & (Nguyen Fig. 1C)

**Regarding claim 21** Lyons in view of Nguyen disclose the integrated circuit comprising a plurality of circuit elements and the semiconductor structure of claim 11, said conductive feature being electrically coupled with at least one of said circuit elements. (Lyons, col. 4, lines 41-54)

**Regarding claim 22** Lyons in view of Nguyen disclose the dielectric material of claim 11 further comprising:

a copolymer layer binding said carbon nanostructures to define said dielectric layer. (Lyons, col. 3, lines 4-28)

**Regarding claim 22** Lyons in view of Nguyen disclose the dielectric material of claim 22 wherein said carbon nanostructure and said copolymer layer have an effective dielectric constant of less than about 3. (Lyons, col. 2 lines 61-67)

**Claims 3, & 6** are rejected under 35 U.S.C. 103(a) as being unpatentable over Lyons et al. (US 6,790,790) in view of Dahl et al. (US 2002/0130407).

**Regarding claims 3 & 6**, Lyons discloses the dielectric material of claim 1.

Lyons does not teach wherein said carbon nanostructures comprise a plurality of fluorinated carbon nanotubes or

... wherein said carbon nanostructures comprise a plurality of fluorinated carbon buckyballs.

Dahl teaches the use of fluorinated amorphous carbon formed by conventional CVD techniques which lead to a film with a lower (and therefore more desirable) dielectric constant. (Dahl, [0135])

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to use fluorinated carbon for nanotubes and buckyballs when making a low-k dielectric film.

Fluorinated amorphous carbon (FLAC, or .alpha.-CF), has a dielectric constant in the range 2.3 to 2.7. (Dahl, [0133])

**Claims 14, &17** are rejected under 35 U.S.C. 103(a) as being unpatentable over Lyons et al. (US 6,790,790) in view of Nguyen et al. (US 2004/0169281) in further view of Dahl et al. (US 2002/0130407).

**Regarding claims 14 & 17**, Lyons et al. in view of Nguyen et al., disclose the dielectric material of claim 11.

Lyons does not teach wherein said carbon nanostructures comprise a plurality of fluorinated carbon nanotubes, or

... wherein said carbon nanostructures comprise a plurality of fluorinated carbon buckyballs.

Dahl teaches the use of fluorinated amorphous carbon formed by conventional CVD techniques which lead to a film with a lower (and therefore more desirable) dielectric constant. (Dahl, [0135])

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to use fluorinated carbon for nanotubes and buckyballs when making a low-k dielectric film.

Fluorinated amorphous carbon (FLAC, or .alpha.-CF), has a dielectric constant in the range 2.3 to 2.7. (Dahl, [0133])

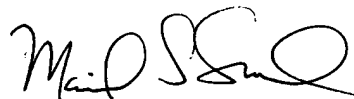
### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jarrett J. Stark whose telephone number is (571) 272-6005. The examiner can normally be reached on Monday - Thursday 7:00AM - 5:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on (571) 272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

JJS  
December 5, 2005



MATTHEW SMITH  
SUPERVISORY PATENT EXAMINER  
TECHNICAL CENTER 2800